

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.

TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045
Tel: (314)298-8566

TestAmerica Job ID: 160-15647-1

Client Project/Site: West Lake Landfill
Revision: 1

For:

Tetra Tech EM Inc.
415 Oak Street
Kansas City, Missouri 64106

Attn: Ms. Emily Fisher



Authorized for release by:
3/30/2016 10:23:42 AM

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Results relate only to the items tested and the sample(s) as received by the laboratory.

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Case Narrative

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Job ID: 160-15647-1

Laboratory: TestAmerica St. Louis

Narrative

CASE NARRATIVE

Client: Tetra Tech EM Inc.

Project: West Lake Landfill

Report Number: 160-15647-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

TestAmerica St. Louis attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the application methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

All solid sample results for Chemistry analyses are reported on an "as received" basis unless otherwise indicated by the presence of a % solids value in the method header. All soil/sediment sample results for radiochemistry analyses are based upon sample as dried and disaggregated with the exception of tritium, carbon-14, and iodine-129 by gamma spectroscopy unless requested as wet weight by the client."

This laboratory report is confidential and is intended for the sole use of TestAmerica and its client.

Revision 1: The client requested that the upper and lower reporting criteria for radiological parameters to be MDC and critical level (DLC).

RECEIPT

The samples were received on 1/8/2016 11:57 AM; the samples arrived in good condition, properly preserved. The temperature of the cooler at receipt was 20.1° C.

Receipt Exceptions

No collection times were listed on CoC, times were taken from sample containers. SED 1-EPA DUP (160-15647-1), SED 2-EPA DUP (160-15647-2) and SED 4-EPA DUP (160-15647-3)

ISOTOPIC THORIUM (ALPHA SPECTROMETRY)

Samples SED 1-EPA DUP (160-15647-1), SED 2-EPA DUP (160-15647-2) and SED 4-EPA DUP (160-15647-3) were analyzed for Isotopic Thorium (Alpha Spectrometry) in accordance with DOE A01R_Th. The samples were dried on 01/08/2016, prepared on 01/13/2016 and analyzed on 01/22/2016.

Case Narrative

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Job ID: 160-15647-1 (Continued)

Laboratory: TestAmerica St. Louis (Continued)

The following samples could not be thoroughly homogenized before sub-sampling was performed due to sample matrix: SED 1-EPA DUP (160-15647-1), SED 2-EPA DUP (160-15647-2) and SED 4-EPA DUP (160-15647-3). The samples contain rocks.

The thorium-229 tracer recovery (125%) is above the 110% QC limit for the MB (Method Blank). The LCS spike recovery is within control limits, which demonstrates acceptable sample preparation and instrument performance. As such, this was an apparent anomaly in the sample preparation, isolated to the MB, which is not indicative of the entire batch. The samples associated with the batch have been truncated to 100% in order to minimize any potential bias a high carrier recovery may have on the results: SED 1-EPA DUP (160-15647-1), SED 2-EPA DUP (160-15647-2), SED 4-EPA DUP (160-15647-3), (LCS 160-232264/2-A), (MB 160-232264/1-A), (490-94645-A-1-F) and (490-94645-A-1-G DU).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

ISOTOPIC URANIUM (ALPHA SPECTROMETRY)

Samples SED 1-EPA DUP (160-15647-1), SED 2-EPA DUP (160-15647-2) and SED 4-EPA DUP (160-15647-3) were analyzed for Isotopic Uranium (Alpha Spectrometry) in accordance with DOE. The samples were dried on 01/08/2016, prepared on 01/13/2016 and analyzed on 01/21/2016.

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

RADIUM-226 BY GAMMA SPEC (21 DAY INGROWTH)

Samples SED 1-EPA DUP (160-15647-1), SED 2-EPA DUP (160-15647-2) and SED 4-EPA DUP (160-15647-3) were analyzed for Radium-226 by gamma spec (21 day ingrowth) in accordance with EPA GA_01_R. The samples were dried on 01/08/2016, prepared on 01/12/2016 and analyzed on 02/02/2016.

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Login Sample Receipt Checklist

Client: Tetra Tech EM Inc.

Job Number: 160-15647-1

Login Number: 15647

List Source: TestAmerica St. Louis

List Number: 1

Creator: Clarke, Jill C

Question	Answer	Comment
Radioactivity wasn't checked or is <=/ background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	False	No collection times were listed on CoC, times were taken from sample containers.
Is the Field Sampler's name present on COC?	N/A	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	False	No collection times were listed on CoC, times were taken from sample containers.
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Definitions/Glossary

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Qualifiers

Rad

Qualifier	Qualifier Description
U	Result is less than the sample detection limit.
F	Duplicate RPD exceeds the control limit
X	Tracer is outside acceptance limits.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
α	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Method Summary

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Method	Method Description	Protocol	Laboratory
A-01-R	Isotopic Thorium (Alpha Spectrometry)	DOE	TAL SL
A-01-R	Isotopic Uranium (Alpha Spectrometry)	DOE	TAL SL
GA-01-R	Radium-226 & Other Gamma Emitters (GS)	DOE	TAL SL

Protocol References:

DOE = U.S. Department of Energy

Laboratory References:

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566



Sample Summary

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-15647-1	SED 1-EPA DUP	Solid	01/06/16 09:20	01/08/16 11:57
160-15647-2	SED 2-EPA DUP	Solid	01/06/16 09:06	01/08/16 11:57
160-15647-3	SED 4-EPA DUP	Solid	01/06/16 08:36	01/08/16 11:57

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Client Sample Results

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Client Sample ID: SED 1-EPA DUP

Lab Sample ID: 160-15647-1

Date Collected: 01/06/16 09:20

Matrix: Solid

Date Received: 01/08/16 11:57

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Thorium-228	0.699		0.152	0.163	0.0722	0.0242	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-230	3.25		0.322	0.422	0.0596	0.0179	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-232	0.693		0.148	0.159	0.0442	0.0103	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Thorium-229	90.4		30 - 110					01/13/16 14:15	01/22/16 12:51	1

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Uranium-233/234	0.748		0.184	0.194	0.0785	0.0227	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-235/236	0.0283		0.0490	0.0490	0.0890	0.0239	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-238	0.737		0.181	0.191	0.0502	0.00856	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Uranium-232	86.4		30 - 110					01/13/16 14:15	01/21/16 11:14	1

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Actinium-227	0.247	U	0.755	0.756	1.29	0.605	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Actinium 228	0.616		0.257	0.265	0.453	0.202	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Bismuth-212	-0.00534	U	0.675	0.675	1.27	0.555	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Bismuth-214	1.08		0.196	0.226	0.142	0.0596	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Lead-210	1.99		1.68	1.70	2.56	1.19	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Lead-212	0.766		0.157	0.185	0.165	0.0760	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Lead-214	1.27		0.198	0.238	0.207	0.0939	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Potassium-40	9.17		1.80	2.03	1.67	0.739	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Protactinium-231	-0.146	U	1.40	1.40	2.50	1.14	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Radium-226	1.08		0.196	0.226	0.142	0.0596	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Radium-228	0.616		0.257	0.265	0.453	0.202	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Thorium-232	0.616		0.257	0.265	0.453	0.202	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Thorium-234	1.28		1.52	1.52	2.58	1.22	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Thallium-208	0.323		0.0863	0.0926	0.0842	0.0360	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Uranium-235	0.0144	U	0.0369	0.0369	0.516	0.240	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Uranium-238	1.28		1.52	1.52	2.58	1.22	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Other Detected Radionuclides			Count	Total						
Other Detected Radionuclide	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Other Detected Radionuclide	None						pCi/g	01/12/16 10:04	02/02/16 09:20	1

TestAmerica St. Louis

Client Sample Results

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Client Sample ID: SED 2-EPA DUP

Lab Sample ID: 160-15647-2

Date Collected: 01/06/16 09:06

Matrix: Solid

Date Received: 01/08/16 11:57

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Thorium-228	0.738		0.162	0.174	0.0890	0.0319	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-230	3.33		0.335	0.437	0.0520	0.0134	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-232	0.651		0.148	0.158	0.0492	0.0121	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Thorium-229	84.5		30 - 110					01/13/16 14:15	01/22/16 12:51	1

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Uranium-233/234	0.966		0.215	0.230	0.0802	0.0224	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-235/236	0.0266		0.0419	0.0419	0.0668	0.0114	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-238	0.935		0.211	0.225	0.0670	0.0158	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Uranium-232	80.2		30 - 110					01/13/16 14:15	01/21/16 11:14	1

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Actinium-227	0.388	U	0.715	0.716	1.21	0.558	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Actinium 228	1.08		0.281	0.302	0.141	0.0445	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Bismuth-212	0.623		0.682	0.686	1.09	0.460	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Bismuth-214	1.50		0.252	0.297	0.173	0.0746	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Lead-210	3.91		1.80	1.86	2.59	1.20	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Lead-212	0.733		0.210	0.230	0.203	0.0947	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Lead-214	1.33		0.204	0.246	0.205	0.0928	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Potassium-40	10.0		1.79	2.06	1.22	0.506	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Protactinium-231	0.232	U	0.496	0.497	2.35	1.06	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Radium-226	1.50		0.252	0.297	0.173	0.0746	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Radium-228	1.08		0.281	0.302	0.141	0.0445	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Thorium-232	1.08		0.281	0.302	0.141	0.0445	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Thorium-234	0.215	U	0.424	0.425	2.88	1.37	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Thallium-208	0.277		0.0865	0.0912	0.0597	0.0235	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Uranium-235	0.323		0.237	0.239	0.358	0.160	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Uranium-238	0.215	U	0.424	0.425	2.88	1.37	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Other Detected Radionuclides			Count	Total						
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Other Detected Radionuclide	Result	Qualifier			MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Other Detected Radionuclide	None						pCi/g	01/12/16 10:04	02/02/16 09:19	1

Client Sample Results

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Client Sample ID: SED 4-EPA DUP

Lab Sample ID: 160-15647-3

Date Collected: 01/06/16 08:36

Matrix: Solid

Date Received: 01/08/16 11:57

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Thorium-228	0.900		0.171	0.187	0.0625	0.0193	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-230	19.8		0.794	1.84	0.0566	0.0164	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-232	0.833		0.163	0.177	0.0489	0.0126	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Thorium-229	95.9		30 - 110					01/13/16 14:15	01/22/16 12:51	1

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Uranium-233/234	0.776		0.188	0.199	0.0684	0.0174	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-235/236	0.0314		0.0494	0.0495	0.0851	0.0216	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-238	0.881		0.199	0.212	0.0509	0.00868	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Uranium-232	90.6		30 - 110					01/13/16 14:15	01/21/16 11:14	1

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
			Uncert.	Uncert.						
			(2σ+/-)	(2σ+/-)						
Actinium-227	0.140	U	0.777	0.777	1.34	0.631	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Actinium 228	0.892		0.233	0.250	0.282	0.115	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Bismuth-212	0.588		0.808	0.810	1.34	0.588	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Bismuth-214	1.68		0.293	0.341	0.203	0.0896	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Lead-210	3.95		2.22	2.27	2.97	1.40	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Lead-212	0.776		0.155	0.185	0.153	0.0704	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Lead-214	1.94		0.275	0.341	0.191	0.0864	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Potassium-40	15.0		2.17	2.66	1.01	0.401	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Protactinium-231	0.694	U	1.70	1.70	2.91	1.35	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Radium-226	1.68		0.293	0.341	0.203	0.0896	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Radium-228	0.892		0.233	0.250	0.282	0.115	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Thorium-232	0.892		0.233	0.250	0.282	0.115	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Thorium-234	0.469	U	0.875	0.877	2.82	1.35	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Thallium-208	0.244		0.0823	0.0861	0.0784	0.0330	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Uranium-235	0.146	U	0.316	0.317	0.581	0.274	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Uranium-238	0.469	U	0.875	0.877	2.82	1.35	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Other Detected Radionuclides	Result	Qualifier	Count Uncert.	Total Uncert.	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Other Detected Radionuclide	None		(2σ+/-)	(2σ+/-)			pCi/g	01/12/16 10:04	02/02/16 09:25	1

QC Sample Results

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Lab Sample ID: MB 160-232264/1-A
Matrix: Solid
Analysis Batch: 233973

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 232264

Analyte	MB MB		Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Thorium-228	0.02625		0.0421	0.0421	0.0741	0.0258	pCi/g	01/13/16 14:15	01/25/16 12:47	1
Thorium-230	0.1688		0.0722	0.0736	0.0420	0.00976	pCi/g	01/13/16 14:15	01/25/16 12:47	1
Thorium-232	0.0000	U	0.00373	0.00373	0.0224	0.00687	pCi/g	01/13/16 14:15	01/25/16 12:47	1
Tracer	MB MB		Limits		Prepared	Analyzed	Dil Fac			
%Yield	Qualifier									
Thorium-229	125	X	30 - 110		01/13/16 14:15	01/25/16 12:47	1			

Lab Sample ID: LCS 160-232264/2-A
Matrix: Solid
Analysis Batch: 233754

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 232264

Analyte	Spike Added	LCS Result	LCS Qual	Total	MDC	DLC	Unit	%Rec	%Rec.
				Uncert. (2σ+/-)					Limits
Thorium-230	24.5	24.42		2.40	0.0879	0.0204	pCi/g	100	81 - 118
Tracer	LCS LCS		Limits		Prepared	Analyzed	Dil Fac		
%Yield	Qualifier								
Thorium-229	95.4		30 - 110						

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Lab Sample ID: MB 160-232283/1-A
Matrix: Solid
Analysis Batch: 233653

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 232283

Analyte	MB MB		Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Uranium-233/234	-0.003589	U	0.0256	0.0256	0.0816	0.0236	pCi/g	01/13/16 14:15	01/21/16 11:15	1
Uranium-235/236	-0.002680	U	0.00536	0.00536	0.0651	0.0111	pCi/g	01/13/16 14:15	01/21/16 11:15	1
Uranium-238	0.01433	U	0.0335	0.0336	0.0700	0.0178	pCi/g	01/13/16 14:15	01/21/16 11:15	1
Tracer	MB MB		Limits		Prepared	Analyzed	Dil Fac			
%Yield	Qualifier									
Uranium-232	83.0		30 - 110		01/13/16 14:15	01/21/16 11:15	1			

Lab Sample ID: LCS 160-232283/2-A
Matrix: Solid
Analysis Batch: 233654

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 232283

Analyte	Spike Added	LCS Result	LCS Qual	Total	MDC	DLC	Unit	%Rec	%Rec.
				Uncert. (2σ+/-)					Limits
Uranium-233/234	6.37	6.057		0.742	0.0735	0.0187	pCi/g	95	84 - 120
Uranium-238	6.51	5.992		0.736	0.0547	0.00932	pCi/g	92	82 - 122
Tracer	LCS LCS		Limits		Prepared	Analyzed	Dil Fac		
%Yield	Qualifier								
Uranium-232	83.0		30 - 110						

TestAmerica St. Louis

QC Sample Results

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Lab Sample ID: MB 160-231792/1-A
Matrix: Solid
Analysis Batch: 235662

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 231792

Analyte	MB MB		Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Actinium-227	0.05522	U	0.234	0.235	0.430	0.184	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Actinium 228	0.01048	U	0.0789	0.0789	0.187	0.0722	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Bismuth-212	0.0000	U	0.199	0.199	0.367	0.116	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Bismuth-214	0.01663	U	0.0598	0.0598	0.111	0.0460	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Lead-210	0.6434		0.698	0.702	1.20	0.532	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Lead-212	-0.01969	U	0.145	0.145	0.0747	0.0329	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Lead-214	0.02057	U	0.0424	0.0424	0.0751	0.0304	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Potassium-40	0.1194	U	0.328	0.328	0.795	0.308	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Protactinium-231	-0.03628	U	0.500	0.500	0.974	0.405	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Radium-226	0.01663	U	0.0598	0.0598	0.111	0.0460	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Radium-228	0.01048	U	0.0789	0.0789	0.187	0.0722	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Thorium-232	0.01048	U	0.0789	0.0789	0.187	0.0722	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Thorium-234	-0.2921	U	1.23	1.23	0.981	0.445	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Thallium-208	0.02602		0.0282	0.0284	0.0436	0.0168	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Uranium-235	0.08392		0.102	0.102	0.186	0.0808	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Uranium-238	-0.2921	U	1.23	1.23	0.981	0.445	pCi/g	01/12/16 10:04	02/02/16 09:21	1
Other Detected Radionuclides	MB MB		Count	Total	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Other Detected Radionuclide	None						pCi/g	01/12/16 10:04	02/02/16 09:21	1

Lab Sample ID: LCS 160-231792/2-A
Matrix: Solid
Analysis Batch: 235661

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 231792

Analyte	Spike Added	LCS Result	LCS Qual	Total	MDC	DLC	Unit	%Rec	%Rec. Limits
				Uncert. (2σ+/-)					
Americium-241	97.2	100.4		10.6	1.24	0.612	pCi/g	103	87 - 116
Cesium-137	29.9	29.71		3.20	0.292	0.139	pCi/g	99	87 - 120
Cobalt-60	17.9	18.28		1.91	0.0587	0.0186	pCi/g	102	87 - 115

Lab Sample ID: 160-15647-1 DU
Matrix: Solid
Analysis Batch: 235660

Client Sample ID: SED 1-EPA DUP
Prep Type: Total/NA
Prep Batch: 231792

Analyte	Sample Sample		DU DU	Total	MDC	DLC	Unit	RER	RER Limit	
	Result	Qual	Result	Qual						Uncert. (2σ+/-)
Actinium-227	0.247	U	-0.2300	U	0.947	1.63	0.766	pCi/g	0.28	1
Actinium 228	0.616		0.8558		0.293	0.173	0.0547	pCi/g	0.43	1
Bismuth-212	-0.00534	U	0.07383	U	0.919	1.70	0.747	pCi/g	0.05	1
Bismuth-214	1.08		1.461		0.310	0.180	0.0759	pCi/g	0.71	1
Lead-210	1.99		3.841		2.35	2.58	1.19	pCi/g	0.46	1
Lead-212	0.766		0.8863		0.215	0.168	0.0768	pCi/g	0.30	1
Lead-214	1.27		1.267		0.285	0.195	0.0865	pCi/g	0.01	1
Potassium-40	9.17		8.496		2.06	1.21	0.475	pCi/g	0.17	1
Protactinium-231	-0.146	U	0.8917	U	1.14	2.25	0.994	pCi/g	0.41	1
Radium-226	1.08		1.461		0.310	0.180	0.0759	pCi/g	0.71	1

TestAmerica St. Louis

QC Sample Results

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS) (Continued)

Lab Sample ID: 160-15647-1 DU
Matrix: Solid
Analysis Batch: 235660

Client Sample ID: SED 1-EPA DUP
Prep Type: Total/NA
Prep Batch: 231792

Analyte	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	MDC	DLC	Unit	RER	
									RER	Limit
Radium-228	0.616		0.8558		0.293	0.173	0.0547	pCi/g	0.43	1
Thorium-232	0.616		0.8558		0.293	0.173	0.0547	pCi/g	0.43	1
Thorium-234	1.28		2.373		2.02	2.71	1.28	pCi/g	0.31	1
Thallium-208	0.323		0.3127		0.101	0.0646	0.0248	pCi/g	0.05	1
Uranium-235	0.0144	U	0.4092	F	0.351	0.472	0.216	pCi/g	1.02	1
Uranium-238	1.28		2.373		2.02	2.71	1.28	pCi/g	0.31	1
Other Detected Radionuclides	Sample Result	Sample Qual	DU Result	DU Qual	Total Uncert. (2σ+/-)	MDC	DLC	Unit	RER	Limit
Other Detected Radionuclide	None		None					pCi/g		

QC Association Summary

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Rad

Leach Batch: 231373

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-15647-1	SED 1-EPA DUP	Total/NA	Solid	Dry and Grind	
160-15647-1 DU	SED 1-EPA DUP	Total/NA	Solid	Dry and Grind	
160-15647-2	SED 2-EPA DUP	Total/NA	Solid	Dry and Grind	
160-15647-3	SED 4-EPA DUP	Total/NA	Solid	Dry and Grind	

Prep Batch: 231792

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-15647-1	SED 1-EPA DUP	Total/NA	Solid	Fill_Geo-21	231373
160-15647-1 DU	SED 1-EPA DUP	Total/NA	Solid	Fill_Geo-21	231373
160-15647-2	SED 2-EPA DUP	Total/NA	Solid	Fill_Geo-21	231373
160-15647-3	SED 4-EPA DUP	Total/NA	Solid	Fill_Geo-21	231373
LCS 160-231792/2-A	Lab Control Sample	Total/NA	Solid	Fill_Geo-21	
MB 160-231792/1-A	Method Blank	Total/NA	Solid	Fill_Geo-21	

Prep Batch: 232264

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-15647-1	SED 1-EPA DUP	Total/NA	Solid	ExtChrom	231373
160-15647-2	SED 2-EPA DUP	Total/NA	Solid	ExtChrom	231373
160-15647-3	SED 4-EPA DUP	Total/NA	Solid	ExtChrom	231373
LCS 160-232264/2-A	Lab Control Sample	Total/NA	Solid	ExtChrom	
MB 160-232264/1-A	Method Blank	Total/NA	Solid	ExtChrom	

Prep Batch: 232283

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-15647-1	SED 1-EPA DUP	Total/NA	Solid	ExtChrom	231373
160-15647-2	SED 2-EPA DUP	Total/NA	Solid	ExtChrom	231373
160-15647-3	SED 4-EPA DUP	Total/NA	Solid	ExtChrom	231373
LCS 160-232283/2-A	Lab Control Sample	Total/NA	Solid	ExtChrom	
MB 160-232283/1-A	Method Blank	Total/NA	Solid	ExtChrom	

Tracer/Carrier Summary

Client: Tetra Tech EM Inc.
Project/Site: West Lake Landfill

TestAmerica Job ID: 160-15647-1

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Matrix: Solid

Prep Type: Total/NA

Percent Yield (Acceptance Limits)

Lab Sample ID	Client Sample ID	Th-229 (30-110)
160-15647-1	SED 1-EPA DUP	90.4
160-15647-2	SED 2-EPA DUP	84.5
160-15647-3	SED 4-EPA DUP	95.9
LCS 160-232264/2-A	Lab Control Sample	95.4
MB 160-232264/1-A	Method Blank	125 X

Tracer/Carrier Legend

Th-229 = Thorium-229

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Matrix: Solid

Prep Type: Total/NA

Percent Yield (Acceptance Limits)

Lab Sample ID	Client Sample ID	U-232 (30-110)
160-15647-1	SED 1-EPA DUP	86.4
160-15647-2	SED 2-EPA DUP	80.2
160-15647-3	SED 4-EPA DUP	90.6
LCS 160-232283/2-A	Lab Control Sample	83.0
MB 160-232283/1-A	Method Blank	83.0

Tracer/Carrier Legend

U-232 = Uranium-232